WHAT IS CLAIMED IS:

1. A monolithic wavelength converter assembly using a common layer structure and including a widely-tunable laser, traveling-wave photodetector (TWPD) and traveling-wave modulator (TWM), wherein an input signal on a first lightwave with a first wavelength creates an electrical signal in the TWPD that propagates along a first interconnecting electrical transmission line to the TWM, where the electrical signal is imprinted onto a second lightwave with a second selectable wavelength derived from the widely-tunable laser, and the electrical signal continues to propagate along a second interconnecting electrical transmission line to a load resistance, R_L.

2. The monolithic wavelength converter assembly of claim 1, wherein an electrical impedance of the TWPD, the first and second interconnecting electrical transmission lines, and TWM all are equal to R_L.

3. The monolithic wavelength converter assembly of claim 1, wherein an electrical impedance of the TWPD, first and second interconnecting electrical transmission lines, TWM and R_L are different, but are chosen to maximize an optical-to-optical signal conversion efficiency or output signal level.

4. The monolithic wavelength converter assembly of claim 1, further comprising a semiconductor optical amplifier (SOA) preceding the TWPD to preamplify the input signal to improve electrical signal level, modulation extinction, output optical signal level or wavelength conversion efficiency.

5. The monolithic wavelength converter assembly of claim 1, wherein the TWPD is a high saturation power photodetector.

6. The monolithic wavelength converter assembly of claim 5, wherein an effective bandgap of an absorber within the TWPD is decreased from larger than a photon energy to lower than the photon energy from an input to an output of the TWPD.

7. The monolithic wavelength converter assembly of claim 1, wherein the wavelength converter assembly provides for optical signal regeneration without using electronic circuits.

8. A monolithic wavelength converter assembly using a common layer structure and including a widely-tunable laser, traveling-wave photodetector (TWPD) and traveling-wave modulator (TWM), wherein the TWPD and TWM are positioned size-by-side within an interconnecting electrical transmission line such that an electrical signal generated by the TWPD in response to an input signal on a first lightwave with a first wavelength simultaneously propagates along the TWM where the electrical signal is imprinted onto a second lightwave with a second selectable wavelength derived from the widely-tunable laser, and the electrical signal continues to propagate along the interconnecting electrical transmission line to a load resistance, R_L.

9. The monolithic wavelength converter assembly of claim 8, wherein an electrical impedance of the TWPD, interconnecting electrical transmission line and TWM all are equal to R_L.

10. The monolithic wavelength converter assembly of claim 8, wherein an electrical impedance of the TWPD, interconnecting electrical transmission line, TWM and R_L are different, but are chosen to maximize an optical-to-optical signal conversion efficiency or output signal level.

11. The monolithic wavelength converter assembly of claim 8, further comprising a semiconductor optical amplifier (SOA) preceding the TWPD to preamplify the input signal to improve electrical signal level, modulation extinction, output optical signal level or wavelength conversion efficiency.

12. The monolithic wavelength converter assembly of claim 8, wherein the TWPD is a high saturation power photodetector.

13. The monolithic wavelength converter assembly of claim 12, wherein an effective bandgap of an absorber within the TWPD is decreased from larger than a photon energy to lower than the photon energy from an input to an output of the TWPD.

14. The monolithic wavelength converter assembly of claim 8, wherein the wavelength converter assembly provides for optical signal regeneration without using electronic circuits.

15. A traveling-wave optoelectronic wavelength conversion assembly, comprising:

a monolithic optoelectronic integrated circuit including an interconnected traveling-wave photodetector (TWPD) and traveling-wave modulator (TWM) with a widely tunable laser source, wherein an input signal modulated onto a first optical wavelength develops a traveling wave voltage on transmission line electrodes of the TWPD, and the traveling wave voltage is coupled via a first interconnecting electrical transmission line to transmission line electrodes of the TWM in order to modulate the input signal onto a second optical wavelength derived from the tunable laser, and the traveling wave voltage continues to propagate along a second interconnecting electrical transmission line to a load resistor.

16. The traveling-wave optoelectronic wavelength conversion assembly of claim 15, wherein the TWPD and TWM are connected in parallel.

17. The traveling-wave optoelectronic wavelength conversion assembly of claim 15, wherein the TWPD and TWM are connected in series.

18. The traveling-wave optoelectronic wavelength conversion assembly of claim 15, wherein the load resistor has a characteristic impedance equal to the second interconnecting electrical transmission line.

19. The traveling-wave optoelectronic wavelength conversion assembly of claim 18, wherein the load resistor and second interconnecting electrical transmission line have different impedances than the TWPD and TWM in order to provide better impedance matching over some signal bandwidth.

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